

Galileo

In 1609, Galileo Galilei peered through his telescope. Galileo, a professor of mathematics in Venice, Italy, did not invent the telescope. But after hearing of the first, crude three-power telescopes, he quickly made a 30-power instrument, the practical limit of its design. Galileo then invited the Venetian Senate to a demonstration. Looking out to sea, senators could see ships sailing toward Venice that were invisible without the telescope. Only hours later did the ships come into normal view. Galileo presented his telescope as a gift to the Venetian Senate. In turn, the Senate awarded Galileo a lifetime teaching position. Venice, a sea power, saw great military and commercial uses for the telescope. Galileo saw another use for it. He dared to turn it toward the heavens.

And what he saw shook the beliefs of the church. The moon was not perfectly smooth. It had mountains, valleys, and "seas" just like the Earth. When he looked at Jupiter, he found four moons circling it. But wasn't every planet supposed to circle only the Earth? The stars through his telescope looked no bigger, only brighter. That had to mean they were incredibly far away. Might the universe be infinite? There were certainly many more stars than the church had known about. They were clustered together like clouds (nebulae). In 1610, he published his findings in a pamphlet called *A Starry Messenger*.

Despite the Senate's job offer, Galileo did not remain in Venice. He had grown tired of teaching and wanted to spend more time pursuing science. So giving telescopes to several wealthy families, Galileo sought a patron. He found one in Cosimo II de' Medici of Florence. Medici arranged for Galileo to become chief mathematician of the University of Pisa. Galileo would not have to teach; he would not even have to live in Pisa. Galileo moved to Florence, and he named the four moons of Jupiter the Medicean planets, after his benefactor Cosimo II de' Medici. (Today they are known as the Galilean moons.)

Galileo could now concentrate on observing the heavens and theorizing. Looking at the sun, he dis-

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Galileo was born in Pisa and died in Florence. This statue of him stands in Florence. →

covered sunspots. Looking at the night sky, he saw what we today call the rings of Saturn. More important, he saw that Venus had phases like the moon. He could not explain these phases if all the heavenly bodies circled the Earth. He could only explain them if Venus circled the sun. So Galileo openly adopted Copernicus' theory of heliocentrism, a sun-centered universe. This put Galileo in direct opposition to church teachings.

A devout Catholic, Galileo saw no reason for the church to reject Copernican theory. He did not think the Bible should be read as a science book. According to him, "The Bible shows the way to go to heaven, not the way heavens go." He traveled to Rome in 1616 to convince the church to accept Copernican theory. He met with Cardinal Bellarmine, a leading Jesuit scholar. Not persuaded by Galileo, Bellarmine told Galileo heliocentrism contradicted the Bible and the Bible must be believed unless evidence demonstrated it wrong. According to Bellarmine, Galileo's evidence was not sufficient. He therefore instructed Galileo not to teach heliocentrism as true. He should treat it as a hypothesis, an idea not proven.

Galileo had pressed so hard for heliocentrism that the church pressed back. For the first time, it put the works of Copernicus on the Index of Prohibited Books. Galileo held little hope of the church approving heliocentrism.

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The Call to Rome

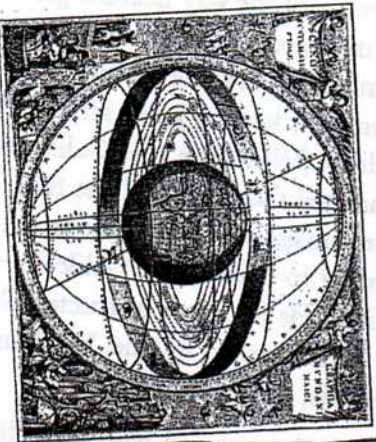
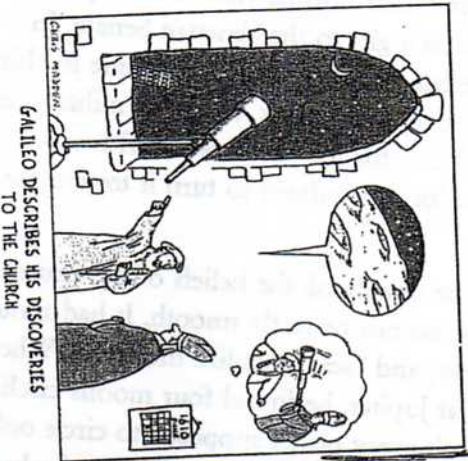
In 1623, a friend of Galileo's, Maffeo Barberini, became Pope Urban VIII. Galileo went to Rome in 1624 hoping the new pope would accept heliocentrism. The pope would not change the church's position. But he did give Galileo permission to write a book explaining the church's and Copernicus' views as long as he presented both sides fairly.

Galileo returned to Florence and spent the next several years writing. His book took the form of a dialogue between three characters. One character defended the church's traditional view of the stationary Earth. Another advocated heliocentrism. A third, supposedly neutral, character examined the arguments of each. Needless to say, the character championing Copernicus came off best.

Although the book was a thinly veiled attack on those opposing heliocentrism, church censors cleared it for publication in 1632. To convince as many as possible, Galileo had written simply and in Italian, the language of the people. Most scholars at that time wrote books in Latin, the language of the church and scholars. His book, *Dialogue on the Two Chief World Systems*, sold out quickly.

And just as quickly it came under attack by members of the church. The book clearly espoused heliocentrism. The character in the book defending the church's position was named Simplicio, meaning simple one. Galileo had made the church's defender a fool. Galileo's enemies charged Simplicio was supposed to be the pope himself.

In 1633, Galileo received an order to appear before the court of Inquisition in Rome. Galileo's doctor sent word back that the scientist, 70 years of age, was gravely ill. The reply from Rome came immediately: either Galileo came to Rome or he would be dragged there in chains. So in the dead of winter, Galileo's friends lifted him into a carriage headed for Rome.



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Galileo's Trial

Galileo knew about Inquisition trials. The normal procedure was for the Inquisitors briefly to inform the accused of the charges, have the accused take an oath, and then ask the accused questions. If the accused did not confess, the Inquisitors often applied torture. Presumed guilty, the accused could have no lawyer, because that would put the lawyer in the position of defending heresy. The accused was not allowed to know who testified at the trial or what they said. Even the dead did not escape the Inquisition. Dead people, accused of heresy, could be tried, and if found guilty, their bodies would be dug up and burned.

The court charged Galileo with violating a written order, an injunction, not to teach or espouse heliocentrism, even as a hypothesis. Galileo supposedly received this injunction from Cardinal Bellarmine at their meeting in 1616. Bellarmine had died, but the court produced the injunction. Galileo had clearly violated it. Therefore he was guilty.

But the injunction was probably forged. Bellarmine had never given Galileo any injunction. He had merely warned Galileo to treat heliocentrism as a hypothesis. Nonetheless, the court accepted the injunction as genuine and found him guilty.

The pope pronounced Galileo's sentence. Galileo would be held in custody indefinitely, his book would be placed on the Index of Prohibited Books, and Galileo would have to disavow his heresy.

Sick, old, and threatened with torture, Galileo did as the court ordered. He declared before the court:

I Galileo, . . . Florentine, aged 70 years, . . . kneeling before you, . . . swear that . . . after [receiving] an injunction . . . that I must altogether abandon the false opinion that the sun is the center of the world and immobile, and that the Earth is not the center of the world and moves, and that I must not hold,

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defend or teach in any way . . . this false doctrine, and after it had been notified to me that this doctrine was contrary to Holy Scripture, I wrote and printed a book in which I . . . brought forth arguments in its favor. . . . I have been judged to be vehemently suspected of heresy, that is, of having held and believed that the sun is in the center of the world and immobile and that the Earth is not the center and moves.

Therefore, desiring to remove from the minds of your Eminences, and of all faithful Christians, this vehement suspicion rightly conceived against me, with sincere heart and unpretended faith I abjure, curse, and detest these errors and heresies. . . . I swear that in the future I will never again say . . . anything that might cause a similar suspicion toward me.

Legend has it that Galileo on the way out of the court whispered, "But if [the Earth] still moves."

Galileo returned to Florence and remained under house arrest until the day he died. But he continued to pursue science. He looked through his telescope until he finally turned blind, his blindness probably caused from looking at the sun. He wrote his greatest book, *Dialogue Concerning Two New Sciences*, a continuing dialogue among the three characters from his previous book. It was smuggled to the north, away from the pope's control, and published.

Galileo died in 1642, the same year that another scientific genius, Isaac Newton, was born. Newton lived in England, far to the north of Galileo's Italy. After Galileo's death, all the great scientific discoveries took place in the north, away from the reaches of the Church of Rome.

The church did not allow a monument to be put on Galileo's tomb until 1737. Galileo's works remained on the Index of Prohibited Books until 1822. In 1992, more than 300 years after Galileo's death, a special commission of the Catholic Church acknowledged that church officials had erred in condemning Galileo.